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(21) International Application Number: PCT/US89/02137 (22) International Filing Date: 17 May 1989 (17.05.89) (71) Applicant (for all designated States except US): WM. WRIGLEY JR. COMPANY [US/US]; 410 North Michigan Avenue, Chicago, IL 60611 (US). (72) Inventors; and (75) Inventors/Applicants (for US only) : PATEL, Mansukh, M. [IN/US]; 3257 Venard Road, Downers Grove, IL 60515 (US). HSU, David, H. [US/US]; 1517 Richards Avenue, Downers Grove, IL 60515 (US). (74) Agent: DUNCAN, Jeffery, M.; William Brinks Olds Hofer Gilson & Lione, NBC Tower, 455 Cityfront Plaza Drive, Suite 3600, Chicago, IL 60611-5599 (US).			(81) Designated States: AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), FI, FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), NO, SE (European patent), US. Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i> <i>Before the expiration of the time limit referred to in Article 21(2)(a) on the request of the applicant.</i>
(54) Title: USE OF SPICE INGREDIENTS TO ENHANCE FLAVOR DURATION OF CHEWING GUM			
(57) Abstract The present invention includes a method of prolonging the flavor duration of a flavored chewing gum by the addition of a minor amount of spice ingredient, as well as the chewing gum so produced. The amount of spice ingredient is selected so as to cause the extension of flavor duration and so as to not impart a detectable modification to the chewing gum flavor. The level of spice ingredient added is between about 0.001 and about 0.4 percent by weight of the chewing gum.			

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USE OF SPICE INGREDIENTS TO ENHANCE FLAVOR DURATION OF CHEWING GUM

BACKGROUND OF THE INVENTION

The present invention relates to chewing gums and their methods of manufacture. More particularly, the present invention relates to a means of increasing the duration of flavor perception of flavored chewing gum.

To impart flavor to gum, the manufacturing process may utilize essential oils, synthetic flavors, or mixtures thereof including oils derived from plants and fruits, such as citrus oils, peppermint oil, spearmint oil, fruit essences, and the like.

The search for a means to extend the flavor duration of a chewing gum has a long history. For example, U.S. Patent No. 4,157,401 discloses a chewing gum that employs a limonene derivative as a means of improving a chewing gum's flavor retention. European Patent Application No. 0150934 discloses a chewing gum with an improved flavor duration accomplished by segregating the chewing gum into various distinct regions, each of which releases flavoring at a different rate. Although the aforesaid patents are but two examples of the past attempts to increase the flavor duration of chewing gum, they are representative in that they address the flavor duration problem by focusing on the particular properties and characteristics of the chewing gum. By way of example, the abovementioned U.S. Patent No. 4,157,401 discloses

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the use of limonene as a method of reducing the flavor migration to the water-soluble portion of the chewing gum base thereby extending the chewing gum's flavor duration.

However, the present invention represents a departure from prior approaches to the problem of extending chewing gum flavor duration. Specifically, the present invention approaches the flavor duration challenge, not from the perspective of what can be done to the gum per se to improve the flavor duration, but rather what can be added to the gum so as to increase the sensitivity of the gum chewer to the flavor contained within the chewing gum. By analyzing gum that had been chewed by individuals to the point wherein the chewer was no longer perceiving flavor it was discovered that a fair amount of flavoring was still present in the chewing gum. For one reason or another the chewer was simply not perceiving the flavor that remained in the chewing gum. Therefore, it would constitute a great advance in the art if there were ingredients which could be added to chewing gum which would allow for the perception of a chewing gum's flavor at levels wherein the flavoring was previously undetectable by the gum chewer, while at the same time, leaving the overall chewing gum taste unaffected.

This and other objects will become apparent to those skilled in the art in light of the following specification. It is to be understood, however, that the above-mentioned objectives are not to be considered a limitation of the present invention, the scope of which is delineated in the appended claims.

SUMMARY OF THE INVENTION

The present invention includes a method of prolonging the flavor duration of a flavored chewing

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gum by the addition of a spice ingredient to the chewing gum in such a quantity so as to increase the flavor duration of the chewing gum, while at the same time, leaving unaffected the chewing gum's overall flavoring. Without being restricted to theory, it is presently believed that the spice ingredients of the present invention stimulate the "hot" sensing portion of the trigeminal nerve of the mouth. In doing so, the spice ingredients increase the gum chewer's sensitivity to flavoring thereby allowing the chewer to perceive flavor when it is present at levels in the chewing gum at which it was previously undetectable in the absence of a spice ingredient. However, the spice ingredient must be present in this chewing gum below the level at which the conscious perception of "hotness" begins.

The chewing gum of the present invention includes a gum base, a sweetener, a flavoring agent, and a minor amount of spice ingredient. The amount of spice ingredient is between about 0.001 and about 0.4 percent by weight of the chewing gum wherein said spice ingredient is selected from the group comprising: Oil Cinnamon Bark; Oil Clove Leaf; Freskomenthe (2-sec-Butylcyclohexanone; Linalool; Oleoresin Capsicum; Oleoresin Black Pepper, or any combination thereof.

There are many and various extraction procedures to obtain and purify the aforesaid spice ingredients from plants. Depending on the particular extraction procedure employed, the level of active ingredient responsible for the "hotness" sensation present in the oil or oleoresin may vary greatly. There are also different types of plants which may yield various types of extracts which can contain various levels of active ingredients. The characteristics of the spice ingredient containing

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extract yielded by a particular plant can even vary depending on the location and climatic conditions where the plant was grown. This is especially true of Oleoresin Capsicum and Oleoresin Black Pepper. The spice extracts may also contain other ingredients which can reduce the effectiveness of the active ingredients, making it necessary to use larger quantities of the spice containing oil or oleoresin extract to be effective. Alternatively, the extracts may be of high purity, and a much smaller amount of oil or oleoresin would be sufficient to be effective.

In accordance with one embodiment of the present invention, the spice ingredient is added to a mint flavored chewing gum. The most widely utilized mint flavored chewing gums employ peppermint and spearmint as well as blends of the two. Typically, peppermint and spearmint flavors are added to chewing gum in the form of essential oils. Oil of peppermint is derived by distillation of the arial parts of the perennial herb Mentha piperita L. Oil of Cornmint, which is derived from Mentha arvensis L. var piperescens, can be blended with peppermint oil. Oil of Spearmint is derived from distillation of several species and varieties of the genus Mentha. The principle species and varieties are Mentha Spicata L. and Mentha verticillata, and Mentha cardiaca. The mint flavoring agent is a blend of natural peppermint oils which is included at a level of between about 0.4 and about 3.0 percent of the chewing gum. Alternatively, the mint flavoring agent can be a blend of natural spearmint oils, or a blend including both natural peppermint oils and natural spearmint oils. Although it is preferred that the spice ingredients be added to mint flavored chewing gum, the present invention also contemplates the use of spice ingredients to extend the flavor duration of fruit flavored chewing gums as well.

As already indicated, at the relatively low level at which the spice ingredients are used in the present invention, they should not modify the overall flavor of the chewing gum. However, it has been found that at this low level the spice ingredients contribute to the flavor duration of the mint flavored chewing gum.

As used in this specification and the appended claims, the term "mint flavored chewing gum" is intended to refer to a chewing gum which has a mint flavor as its dominant flavor.

Unless otherwise noted, all percentages in this specification and the appended claims are percentages by weight of the total chewing gum formulation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The flavored chewing gum of the present invention includes a gum base, a sweetener, a flavoring agent, and a minor amount of spice ingredient.

The spice ingredient used in the present invention can be any ingredient, or combination thereof, from the group comprising: Oil Cinnamon Bark; Oil Clove Leaf; Freskomenthe (2-sec-Butylcyclohexanone); Linalool; Oleoresin Capsicum; and Oleoresin Black Pepper.

The amount of spice ingredient added to the chewing gum should be between about 0.001 and about 0.4 percent. In particular, it is important that the amount of spice ingredient be kept below the level at which it would impart a noticeable modification of the chewing gum flavor. It is also important that the amount of spice ingredient be above a level at which the enhanced flavor duration effect is detectable.

When the spice ingredient added to the chewing gum is Oil Cinnamon Bark it is preferred that it is added in an amount between about 0.01 and about

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0.1 percent. When the spice ingredient added to the chewing gum is Oil Clove Leaf it is preferred that it is added in an amount between about 0.01 and about 0.1 percent. When the spice ingredient added to the chewing gum is Freskomenthe it is preferred that it is added in an amount between about 0.01 and about 0.1 percent. When the spice ingredient added to the chewing gum is Linalool it is preferred that it is added in an amount between about 0.01 and about 0.1 percent. When the spice ingredient added to the chewing gum is Oleoresin Capsicum it is preferred that it is added in an amount between about 0.001 and about 0.02 percent. Finally, when the spice ingredient added to the chewing gum is Oleoresin Black Pepper it is preferred that it is added in an amount between 0.002 and about 0.05 percent.

The spice ingredients can be added to the flavored chewing gum at any point during its formulation.

Chewing gum bases generally comprise a combination of elastomers and resins together with plasticizers and inorganic fillers.

The gum base may contain natural gums and/or synthetic elastomers and resins. Natural gums include both elastomers and resins. Suitable natural gums include, but are not limited to chicle, jellutong, sorva, nispero tunu, niger gutta, massaranduba belata, and chiquibul.

When no natural gums are used, the gum base is referred to as "synthetic" and the natural gums are replaced with synthetic elastomers and resins. Synthetic elastomers may include polyisoprene, polyisobutylene, isobutylene-isoprene copolymer, styrene butadiene rubber, and the like. Of these, polyisoprene, isobutylene and isobutylene-isoprene copolymer are preferred, with the copolymer being the

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most preferred. A copolymer obtained from Exxon Corp. under the designation "butyl rubber" is suitable for use in the most preferred embodiment.

The amount of elastomer used in the gum base can typically be varied between about 10 and about 20 percent depending on the specific elastomer selected and on the physical properties desired in the final gum base. For example, the viscosity, softening point, and elasticity can be varied.

Resins used in gum bases include polyvinyl acetate, polyethylene, ester gums, (resin esters of glycerol) and polyterpenes. Of these, polyterpenes, polyethylene, and polyvinyl acetate are preferred, with a combination of polyvinyl acetate and polyterpenes being most preferred. A polyvinyl acetate obtained from MONSANTO under the designation "Gelva" is a suitable polyvinyl acetate for use in the most preferred embodiment. A polyterpene obtained from HERCULES under the designation "Piccolyte" is suitable for use in the most preferred embodiment.

As with the elastomer, the amount of resin used in the gum base can be varied depending on the particular resin selected and on the physical properties desired in the final gum base.

Preferably, the gum base also includes plasticizers selected from the group consisting of fats, oils, waxes, and mixtures thereof. The fats and oils can include tallow, hydrogenated and partially hydrogenated vegetable oils, and cocoa butter. Commonly employed waxes include paraffin, microcrystalline and natural waxes such as beeswax and carnauba.

The most preferred embodiment uses a mixture of paraffin wax and partially hydrogenated vegetable oil and glycerol monostearate.

The amount of plasticizers used can vary between about 10 and about 40 percent. In the most preferred embodiment, the plasticizer includes paraffin wax at about 13 percent and cottonseed oil at about 2 percent, and glycerol monostearate at about 5 percent.

Preferably, the gum base also includes a filler component. The filler component is preferably selected from the group consisting of calcium carbonate, magnesium carbonate, talc, dicalcium phosphate and the like. The filler may constitute between about 5 to about 60 percent by weight of the gum base. Preferably, the filler comprises about 5 to about 50 percent by weight of the gum base.

Further, gum bases may also contain optional ingredients such as antioxidants, colors, and emulsifiers.

These ingredients of the gum base can be combined in a conventional manner. In particular, the elastomer, resins, plasticizers, and the filler are typically softened by heating and then mixed for a time sufficient to insure a homogenous mass. The mass can be formed into slabs, or pellets and allowed to cool before use in making chewing gum. Alternatively, the molten mass can be used directly in a chewing gum making process.

Typically, the gum base constitutes between about 5 to about 95 percent by weight of the gum. More preferably the insoluble gum base comprises between 10 and 50 percent by weight of the gum and most preferably about 20 to about 35 percent by weight of the gum.

In general, a chewing gum composition typically comprises a water soluble bulk portion added to the water insoluble chewable gum base portion. The flavoring agents are typically water insoluble. The water soluble portion dissipates with a portion of the flavoring agent over a period of time during chewing,

while the gum base portion is retained in the mouth throughout the chew.

The water soluble portion of the chewing gum may further comprise softeners, sweeteners, flavoring agents and combinations thereof. Softeners are added to the chewing gum in order to optimize the chewability and mouth feel of the gum. Softeners, also known in the art as plasticizers or plasticizing agents, generally constitute between about 0.5 to about 15.0 percent by weight of the chewing gum. Softeners contemplated by the present invention include glycerin, lecithin, and combinations thereof. Further, aqueous sweetener solutions such as those containing sorbitol, hydrogenated starch hydrolysates, corn syrup and combinations thereof may be used as softeners and binding agents in the chewing gum. Preferably, the chewing gum contains about 1 percent glycerine.

Sugar sweeteners generally include saccharide containing components commonly known in the chewing gum art which comprise but are not limited to sucrose, dextrose, maltose, dextrin, dried invert sugar, fructose, levulose, galactose, corn syrup solids, and the like, alone or in any combination. In the preferred embodiment, the water soluble sweetener portion is a mixture of sugar at about 50 percent of the final chewing gum, dextrose monohydrate at about 10 percent, and corn syrup at about 13 percent.

In alternative embodiments, the invention can be used in a sugarless chewing gum. Generally sugarless sweeteners include components with sweetening characteristics but are devoid of the commonly known sugars and comprise but are not limited to high-potency sweeteners and/or sugar alcohols. Suitable high-potency sweeteners include aspartame, alitame, salts of acesulfame, saccharin and its salts, cyclamic

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acid and its salts, glycyrrhizin, sucralose, thaumatin, and monellin, as well as combinations thereof. Suitable sugar alcohols include sorbitol, mannitol, xylitol, hydrogenated starch hydrolysates, maltitol, and the like, as well as combinations thereof. Preferably, the sugarless gum comprises a combination of a high-potency sweetener with a sugar alcohol, most preferably aspartame with sorbitol.

According to a preferred embodiment of the present invention, the chewing gum includes a mint flavoring agent to give the gum a mint taste. Typically, the overall mint flavoring agent content of the chewing gum will range from about 0.1 to about 10.0 weight percent and preferably from about 0.4 to about 3.0 weight percent of the gum.

The mint flavoring agents preferably comprise blends of natural peppermint oils and/or spearmint oils. Alternatively, the mint flavoring agents used in the invention can comprise blends which include synthetic components, such as synthetic menthol, synthetic carvone, and the like. In the most preferred embodiment, the mint flavoring agent is a blend of natural peppermint oils added at about 0.9 percent by weight of the chewing gum.

Other, non-mint flavoring agents and adjuvants can also be added to the chewing gum of the present invention. For example, the flavor may comprise essential oils, synthetic flavors, or mixtures thereof, including but not limited to oils derived from plants and fruits such as citrus oils, fruit essences, clove oil, oil of wintergreen, anise, and the like. Also, flavor chemicals such as furanones which give a caramel flavor note can be added. Those skilled in the art will recognize that natural and artificial flavoring agents may be combined in any sensorally

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acceptable blend. All such flavors and flavor blends which result in a mint or fruit flavored gum are contemplated by the present invention.

Optional ingredients such as colors, emulsifiers and pharmaceutical agents may be added to the chewing gum.

In general, chewing gum is manufacture by sequentially adding the various chewing gum ingredients to a commercially available mixer known in the art. After the ingredients have been thoroughly mixed, the gum mass is discharged from the mixer and shaped into the desired form such as by rolling into sheets and cutting into sticks, extruding into chunks or casting into pellets.

Generally, the ingredients are mixed by first melting the gum base and adding it to the running mixer. The base may also be melted in the mixer itself. Color or emulsifiers may also be added at this time. A softener such as glycerin may also be added at this time along with syrup and a portion of bulking agent. Further portions of the bulking agent may then be added to the mixer. The flavoring agent is typically added with the final portion of the bulking agent.

The entire mixing procedure typically takes from five to fifteen minutes, but longer mixing times may sometimes be required. Those skilled in the art will recognize that many variations of the above

described procedure may be followed.

EXAMPLE

A peppermint control gum was made according to the ingredients in TABLE 1. The peppermint flavoring of the control gum consisted of a blend of

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natural peppermint oils. Prior to the addition of the peppermint flavoring to the test gums, a spice ingredient was substituted for a specific percentage of flavoring and was preblended with the peppermint flavor. As another control, the same amount of spice ingredient added to the peppermint test gums was added to a triacetin containing control gum to determine the characteristics of the spice ingredient itself. Samples of the gum were evaluated by three panelists for flavor intensity over a five minute period. The panelists recorded the perceived flavor intensity on a scale of 1-7 with 1 being very low and 7 being very high. The tabulated results are shown in TABLE 2.

TABLE 1

Gum Base	20.2%
Sucrose	54.4%
Dextrose Monohydrate	9.9%
Corn syrup	13.3%
Glycerin	1.3%
Peppermint flavor blend	0.9%
	<hr/> 100 %

TABLE 2

<u>Chewing Gum</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Peppermint Control ¹	5.52	4.95	3.17	1.90	1.32
3.5% Oil Cinnamon Bark ¹	5.97	5.30	3.65	2.78	2.17
4.0% Clove Leaf Oil ¹	5.60	4.82	3.62	2.57	2.22
2.0% Feskomenthe ¹	5.35	4.37	3.28	2.67	2.10
4.0% Linalool ¹	5.40	4.23	3.60	2.55	2.07
0.4% Oleoresin Capsicum	15.42	4.60	3.67	2.97	2.60

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Peppermint Control 2 ²	6.13	4.98	3.87	2.32	1.73
1% Oleoresin Black Pepper ¹	5.65	4.82	3.50	2.78	2.38

- ¹ Usage levels given as % of flavor replaced
² A second control was made for proper comparison as the 1% Oleoresin Black Pepper Chewing Gum was evaluated at a different time and by different panelists.

As the above table indicates, the spice ingredients when used in peppermint flavor chewing gum show no significant increase in flavor perception during the first three minutes of chewing. However, at minute 4 and especially at minute 5, the intensity of flavor perceived is stronger in all of the spice ingredient containing peppermint gums than it is in the standard peppermint gum. Gum samples that were made with the spice/triacetin blend had very low flavor intensity at 1, 2, and 3 minutes and virtually no flavor intensity at minutes 4 and 5.

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WE CLAIM:

1. A chewing gum comprising:
gum base;
sweetener; and
a spice ingredient present in an amount
between about 0.001 and about 0.4 percent, wherein said
spice ingredient is any one, or combination thereof,
from the group comprising:
 - (a) Oil Cinnamon Bark;
 - (b) Oil Clove Leaf;
 - (c) Freskomenthe (2-sec-Butylcyclohexanone);
 - (d) Linalool;
 - (e) Oleoresin Capsicum; and
 - (f) Oleoresin Black Pepper.
2. The chewing gum of Claim 1 wherein the spice
ingredient is Oil Cinnamon Bark present in an amount
between about 0.01 and about 0.1 percent.
3. The chewing gum of Claim 1 wherein the spice
ingredient is Oil Clove Leaf present in an amount
between about 0.01 and about 0.1 percent.
4. The chewing gum of Claim 1 wherein the spice
ingredient is Freskomenthe present in an amount between
about 0.01 and about 0.1 percent.
5. The chewing gum of Claim 1 wherein the spice
ingredient is Linalool present in an amount between
about 0.01 and about 0.1 percent.

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6. The chewing gum of Claim 1 wherein the spice ingredient is Oleoresin Capsicum present in an amount between about 0.001 and about 0.02 percent.

7. The chewing gum of Claim 1 wherein the spice ingredient is Oleoresin Black Pepper present in an amount between about 0.002 and about 0.05 percent.

8. The chewing gum of claim 1 wherein the flavoring agent is selected from the group consisting of natural peppermint oil, natural spearmint oil, and combinations thereof.

9. The chewing gum of Claim 1 wherein the sweetener is a high - potency sweetener selected from the group consisting of aspartame, alitame, salts of acesulfame, saccharin and its salts, cyclamic acid and its salts, glycyrrhizin, sucralose, thaumatin, and monellin, as well as combinations thereof.

10. The chewing gum of Claim 9 further comprising a sugar alcohol selected from the group consisting of sorbitol, mannitol, maltitol, xylitol, hydrogenated starch hydrolysates, and mixtures thereof.

11. The chewing gum of Claim 1 further comprising a sugar alcohol selected from the group consisting of sorbitol, mannitol, maltitol, xylitol, hydrogenated starch hydrolysates, and mixtures thereof.

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12. A method of making chewing gum comprising the steps of:

providing a quantity of chewing gum base;
adding a water soluble portion comprising at least a sweetener;

adding a flavoring agent;

adding a spice ingredient in an amount between about 0.001 and about 0.4 percent by weight of the chewing gum, wherein said spice ingredient is any one, or combination thereof, from the group comprising:

- (a) Oil Cinnamon Bark;
- (b) Oil Clove Leaf;
- (c) Freskomenthe (2-sec-Butylcyclohexanone);
- (d) Linalool;
- (e) Oleoresin Capsicum; and
- (f) Oleoresin Black Pepper, and

mixing said gum base, water soluble portion, flavoring agent, and spice ingredient until a homogenous mass is achieved.

13. The method of Claim 12 wherein the spice ingredient is Oil Cinnamon Bark present in an amount between about 0.01 and about 0.1 percent.

14. The method of Claim 12 wherein the spice ingredient is Oil Clove Leaf present in an amount between about 0.01 and about 0.1 percent.

15. The method of Claim 12 wherein the spice ingredient is Freskomenthe present in an amount between about 0.01 and about 0.1 percent.

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16. The method of Claim 12 wherein the spice ingredient is Linalool present in an amount between about 0.01 and about 0.1 percent.

17. The method of Claim 12 wherein the spice ingredient is Oleoresin Capsicum present in an amount between about 0.001 and about 0.02 percent.

18. The method of Claim 12 wherein the spice ingredient is Oleoresin Black Pepper present in an amount between about 0.002 and about 0.05 percent.

19. The method of Claim 12 wherein the flavoring agent is selected from the group consisting of natural peppermint oil, natural spearmint oil, and combinations thereof.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US89/02137

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC (5): A23G 3/30; A23L 1/221; A23L 1/226 U.S. CL.: 426/3, 4, 5, 6, 534, 550, 651																													
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Minimum Documentation Searched ⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border: 1px solid black; text-align: left;">Classification System</th> <th style="border: 1px solid black; text-align: left;">Classification Symbols</th> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">U.S.</td> <td style="border: 1px solid black; padding: 5px;">426/3, 4, 5, 6, 534, 650, 651</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸</div>			Classification System	Classification Symbols	U.S.	426/3, 4, 5, 6, 534, 650, 651																							
Classification System	Classification Symbols																												
U.S.	426/3, 4, 5, 6, 534, 650, 651																												
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; border: 1px solid black; text-align: left;">Category [*]</th> <th style="width: 70%; border: 1px solid black; text-align: left;">Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²</th> <th style="width: 20%; border: 1px solid black; text-align: left;">Relevant to Claim No. ¹³</th> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">X</td> <td style="border: 1px solid black; vertical-align: top;">U.S. A, 4,722,845 CHERUKURI ET AL 02 February 1988 (Col 9 lines 15-30)</td> <td style="border: 1px solid black; text-align: center; vertical-align: top;">1-19</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">Y</td> <td style="border: 1px solid black; vertical-align: top;">U.S. A, 2,886,446 KRAMER ET AL 12 May 1959 (Cols 3-5)</td> <td style="border: 1px solid black; text-align: center; vertical-align: top;">1-19</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">Y</td> <td style="border: 1px solid black; vertical-align: top;">U.S. A, 4,317,837 KEHOE ET AL 02 March 1982 (Cols 4-5)</td> <td style="border: 1px solid black; text-align: center; vertical-align: top;">1-19</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">Y</td> <td style="border: 1px solid black; vertical-align: top;">U.S. A, 4,822,597 FAUST ET AL 18 April 1989 (Col 4)</td> <td style="border: 1px solid black; text-align: center; vertical-align: top;">1-19</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">Y</td> <td style="border: 1px solid black; vertical-align: top;">U.S. A, 3,826,847 OGAWA ET AL 30 July 1974 (Col 2)</td> <td style="border: 1px solid black; text-align: center; vertical-align: top;">1-19</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">Y, E</td> <td style="border: 1px solid black; vertical-align: top;">U.S. A, 4,844,883 PATEL 04 July 1989 (Cols 7, 8 and Table II)</td> <td style="border: 1px solid black; text-align: center; vertical-align: top;">1-19</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">Y</td> <td style="border: 1px solid black; vertical-align: top;">U.S. A, 4,808,418 ZAMUDIO-TENA ET AL 28 February 1989 (Col 6)</td> <td style="border: 1px solid black; text-align: center; vertical-align: top;">1-19</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">Y</td> <td style="border: 1px solid black; vertical-align: top;">U.S. A, 4,485,118 CARROLL ET AL 27 November 1984 (Cols 5 and 12)</td> <td style="border: 1px solid black; text-align: center; vertical-align: top;">1-19</td> </tr> </table>			Category [*]	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	X	U.S. A, 4,722,845 CHERUKURI ET AL 02 February 1988 (Col 9 lines 15-30)	1-19	Y	U.S. A, 2,886,446 KRAMER ET AL 12 May 1959 (Cols 3-5)	1-19	Y	U.S. A, 4,317,837 KEHOE ET AL 02 March 1982 (Cols 4-5)	1-19	Y	U.S. A, 4,822,597 FAUST ET AL 18 April 1989 (Col 4)	1-19	Y	U.S. A, 3,826,847 OGAWA ET AL 30 July 1974 (Col 2)	1-19	Y, E	U.S. A, 4,844,883 PATEL 04 July 1989 (Cols 7, 8 and Table II)	1-19	Y	U.S. A, 4,808,418 ZAMUDIO-TENA ET AL 28 February 1989 (Col 6)	1-19	Y	U.S. A, 4,485,118 CARROLL ET AL 27 November 1984 (Cols 5 and 12)	1-19
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>[*] Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"Δ" document member of the same patent family</p> </div> </div>																													
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of the Actual Completion of the International Search <div style="text-align: center; font-weight: bold;">16 January 1990</div> </td> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of Mailing of this International Search Report <div style="text-align: center; font-weight: bold; font-size: 1.2em;">06 FEB 1990</div> </td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;"> International Searching Authority <div style="text-align: center; font-weight: bold;">ISA/US</div> </td> <td style="border: 1px solid black; padding: 5px;"> Signature of Authorized Officer <div style="text-align: center;"> JEANETTE M. HUNTER </div> </td> </tr> </table>			Date of the Actual Completion of the International Search <div style="text-align: center; font-weight: bold;">16 January 1990</div>	Date of Mailing of this International Search Report <div style="text-align: center; font-weight: bold; font-size: 1.2em;">06 FEB 1990</div>	International Searching Authority <div style="text-align: center; font-weight: bold;">ISA/US</div>	Signature of Authorized Officer <div style="text-align: center;"> JEANETTE M. HUNTER </div>																							
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FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET**Y****U.S. A, 4,775,537 CALABRO ET AL 04 October
1988 (Cols 4-6)****1-19****V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE ¹**

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers _____, because they relate to subject matter ¹² not required to be searched by this Authority, namely:
2. ☐ Claim numbers _____, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out ¹³, specifically:
3. ☐ Claim numbers _____, because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING ²

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

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